Biomarker and Histopathologic Responses Demonstrate Improvement in Flatfish Health Following Remediation of a PAH-contaminated Site in Eagle Harbor, WA

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Eagle Harbor in Puget Sound became a Superfund site in 1987 due to high sediment concentrations of polycyclic aromatic hydrocarbons (PAHs) released chronically from a nearby creosoting facility. Early studies with English sole from this site (1983-86) demonstrated high prevalences (up to ~75%) of toxicopathic liver lesions, including neoplasms, in resident fish. These lesions have been strongly and consistently associated with PAH exposure in multiple field studies. Neoplasia-related liver lesions have been induced in sole by injections of a PAH-rich fraction extracted from Eagle Harbor sediment. Further studies (1986-88) incorporated biochemical biomarkers of PAH exposure and effect, including hepatic CYP1A expression, biliary fluorescent aromatic compounds (FACs), and DNA adducts in liver. Prior to site remediation, hepatic lesion prevalences and biomarker values in these species from Eagle Harbor were among the highest in Puget Sound. In a combined USEPA/US Army Corps of Engineers effort, a cap of clean sediment was placed (9/93-3/94) over the most contaminated portions of Eagle Harbor, to sequester PAH-contaminated sediments. Lesion prevalences and biomarker values just before capping were somewhat reduced compared to historical data, consistent with creosoting facility closure and shore-based source controls. Data on liver lesion risk, hepatic CYP1A, and biliary FACs from fish collected immediately after and at regular intervals up to ~2 years after sediment capping were highly variable relative to pre-capping values. However,over the entire monitoring period (up to 128 months) since cap initiation, but particularly after ~2 years, there was an overall, significantly decreasing trend in risk for hepatic lesions in English sole, and for biliary FACs and hepatic DNA adducts. In particular, the risk of hepatic lesion occurrence in English sole has been consistently low (> 0.20) compared to lesion risk at cap initiation (1.0), from ~4 years after sediment cap placement through May 2004. These results show that the sediment capping process has been relatively effective in ameliorating PAH exposure and associated biological effects in resident flatfish species, and that longer term monitoring of pollutant responses in biological resources, such as resident fish, is necessary to demonstrate the efficacy of this type of sediment remediation.